Sensor Enhanced and Model Validated Life Extension of Li-Ion Batteries for Energy Storage

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Progress toward the vision of AMPED

Develop sensor technology for health and safety monitoring of lithium ion batteries

Improved Safety

- 10 minutes of early warning in severe failure modes
- Detection of cell damage at pack level prior to detection by conventional means

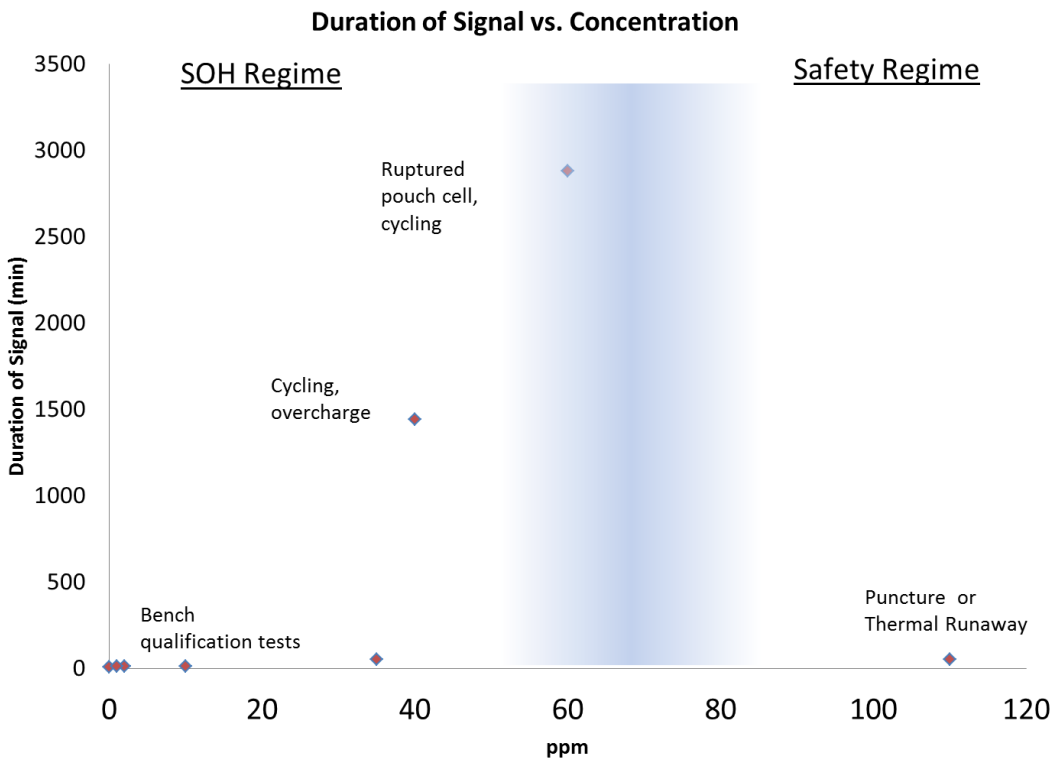
Reduction in Size and Packaging

- Demonstration of second life for increased throughput
- Optimization of sensor placement in DES units
- Increased risk tolerance for smaller systems with greater capacity utilization

Life Prediction

- Trend of increasing frequency and intensity as battery ages
- Coupling of Battery XT life predictions with sensor results
- Demonstration of SOH indication

State of Health Indication



ABUSE SPECTRUM

State of Health:

Discrete, low concentration emissions, increasing in intensity as ageing occurs.

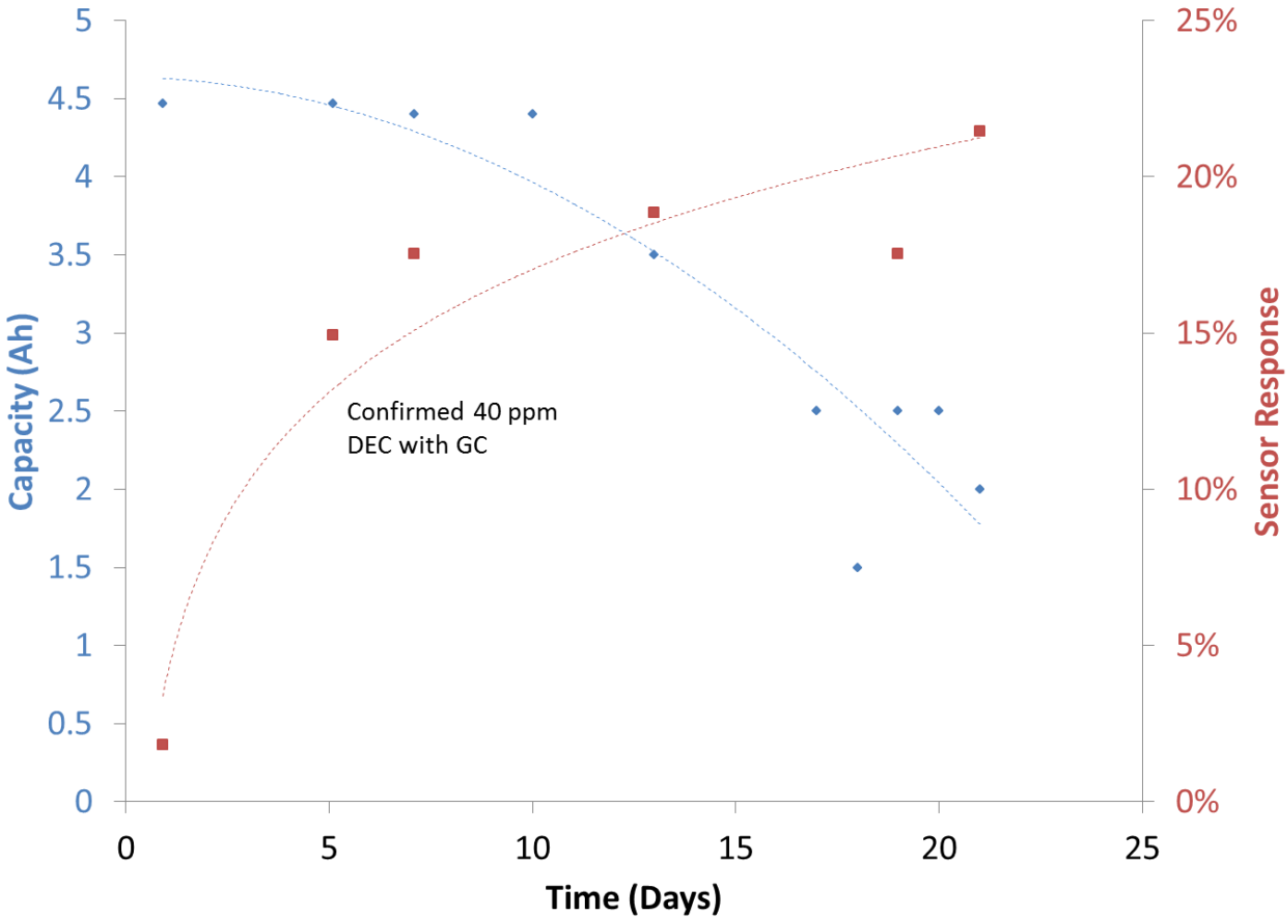
Safety:

Quick, intense response, early warning to catastrophic failure.

Key Deliverables:

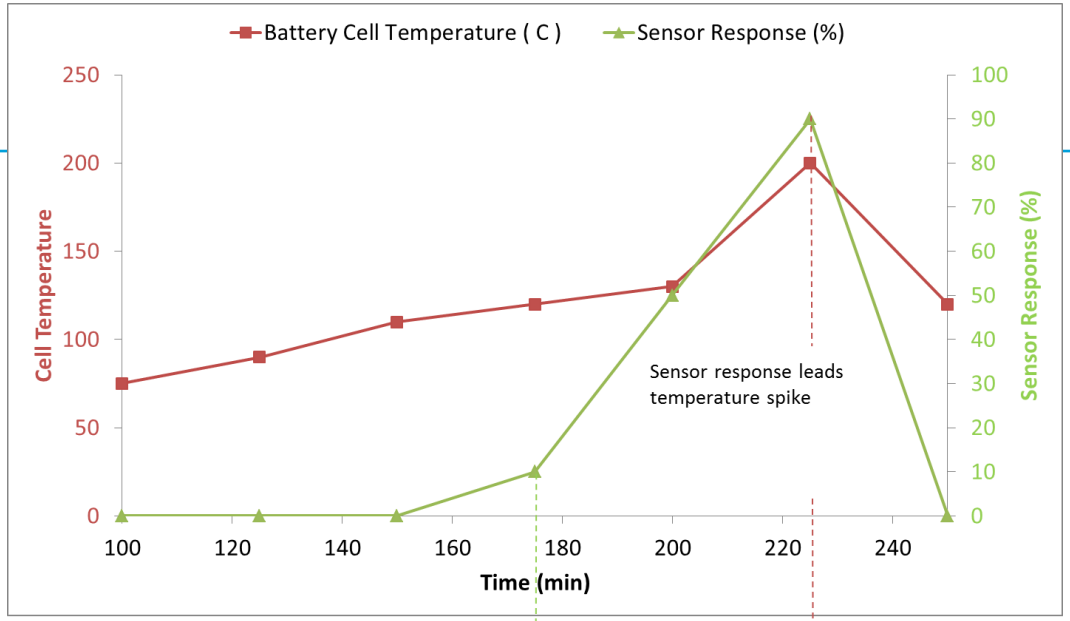
- *Confirmed off gas behavior from punctured cells (triplicate)*
- *Multiple confirmations (with GC) from COTS overcharged cells*
- *Testing of 2nd life cells*

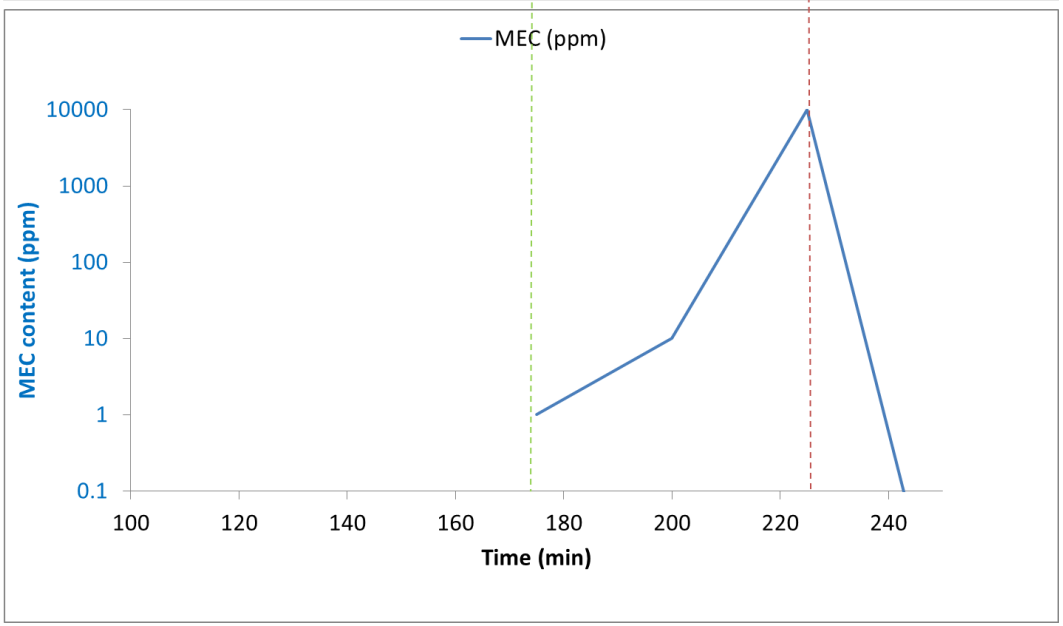
Off gas as Battery Ages (slight overcharge per cycle)



Safety

Sensor response climbs 10% prior to temperature spike by 10-20 minutes.





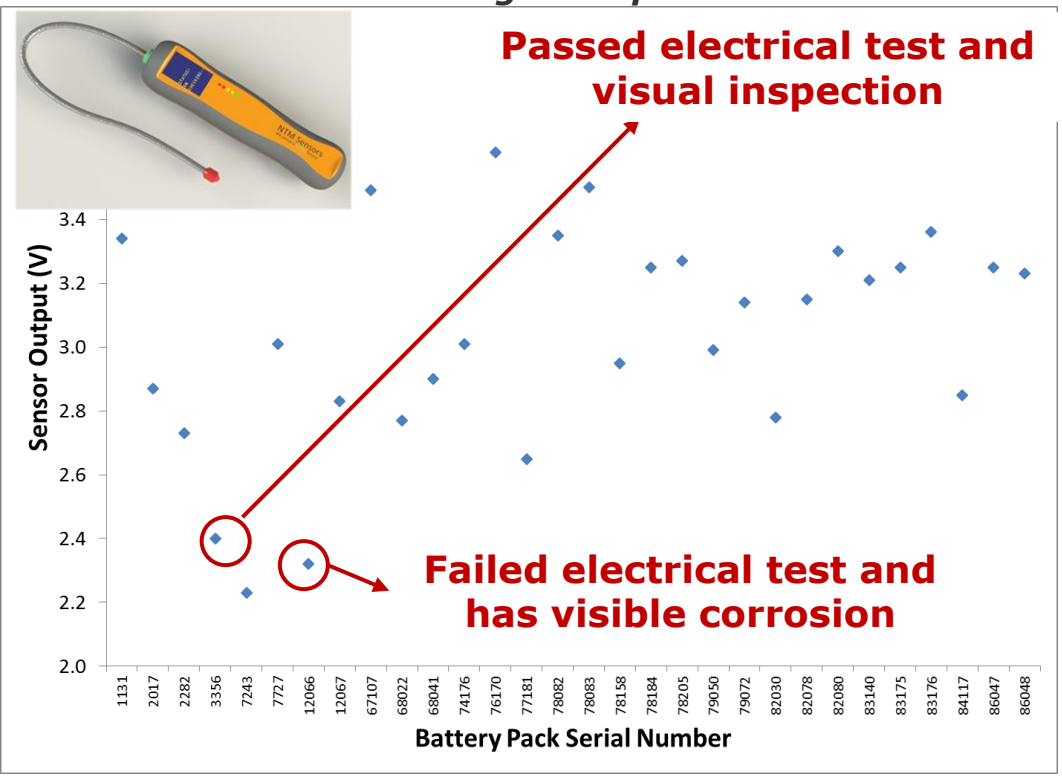
T2M: BMS Diagnostics and Inspection

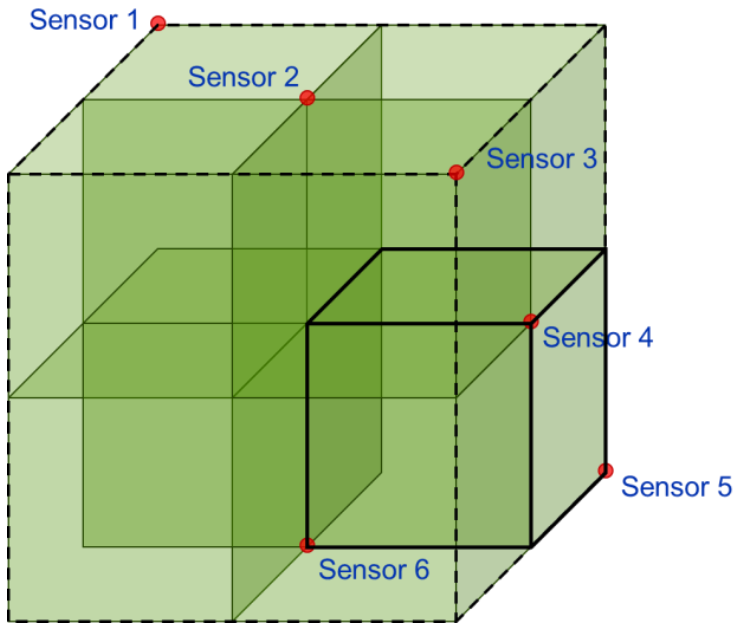
Multiple market opportunities:

Monitoring at pack level for stationary storage

Hand-held wand for QC and diagnostics

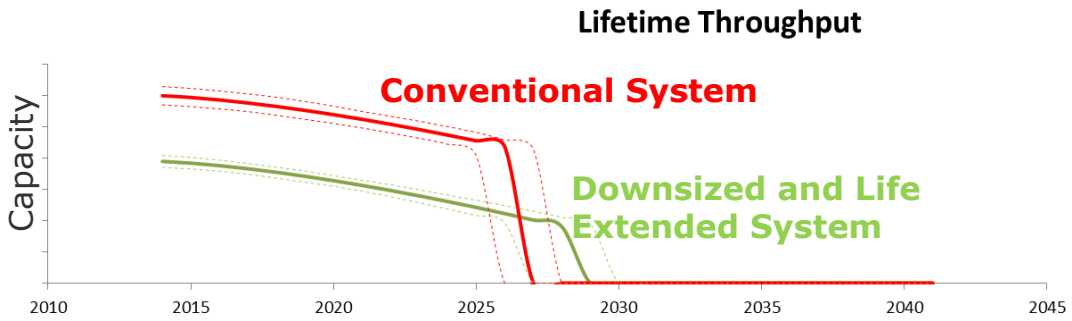
ATC New Technologies inspections





Beckett DESS System

How does this affect cost?



Preliminary analysis:

Monitoring enables life extension and downsizing for best ROI.

Control mechanisms affected by sensing:

- Life Extension
- Downsizing (less overdesign)
- Bypassable modules
- More aggressive cycling (higher DOD, more SOC, higher C-rates)

Case Studies for Technoeconomic Analysis

Life Extension	Downsizing	Bypassable Modules	Aggressive Cycling	Monitoring
			X	X
X				X
X			X	X
X	X			X
X		X		X
X	X	X		X
X	X	X	X	X

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